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The Cambrian-Ordovician Stratigraphic Column in Southeastern Newfoundland

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BY

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THE CAMBRIAN-ORDOVICIAN STRATIGRAPHIC COLUMN OF SOUTHEASTERN NEWFOUNDLAND

By BEN. F. HOWELL

INTRODUCTION

THE sedimentary rocks, ranging in age from Lower Cambrian to late Lower or early Middle Ordovician, which have been found in southeastern Newfoundland, are of more than ordinary interest to stratigraphers and palaeontologists because of the abundance, variety, and excellent preservation of their fossils, and of the remarkable way in which these fossils resemble those found in beds of corresponding age in northwestern Europe. Much work will have to be done on many of the Newfoundland beds and fossils before we shall be in a position to give a detailed account of their exact sedimentary and faunal succession, detailed geographic distribution, and local development; but a brief summary of our present knowledge may perhaps be appropriately presented now.

Much of the information on which this paper is based was gathered by members of the three geological expeditions from Princeton University which worked in southeastern Newfoundland in 1912, 1913 and 1914; and the late Professor Gilbert van Ingen, who organized and led these field parties, would have been far more competent than the writer to describe the early Paleozoic rocks of that region. In acceding to the request of the editors to undertake this task, the writer has been actuated by a desire to make available to the scientific world some of the many facts which Professor van Ingen had gathered together, but which he was unable to publish because of ill health and the pressure of other duties. The writer would also express his indebtedness to the late Messrs. Alexander Murray and James P. Howley, of the Newfoundland Geological Survey, who gave us the first detailed account of the sedimentary rocks of southeastern Newfoundland; to the late Dr. G. F. Matthew and to Dr. Charles D. Walcott, who added much to our knowledge of the stratigraphy and palaeontology of the beds; to Dr. Albert O. Hayes who, with Professor van Ingen, first worked out the detailed stratigraphy of the Ordovician section in the Conception Bay district; and to Professor Nelson C. Dale, who described the Cambrian manganese beds about Conception Bay and studied the Cambrian rocks along the shores of Fortune Bay. The Cambrian fossils referred to have been identified by the writer. The identifications of the Ordovician ones are by Professor van Ingen.

THE SECTION

The Lower Paleozoic sediments of southeastern Newfoundland are shales and sandstones, with a few limestones, limy shales and limy nodules in the Lower Cambrian and the overlying Paradoxides beds, and with limy concretions in the Upper Cambrian, and a sandy limestone in the succeeding Tremadocian. Their character, faunas, and order of superposition are indicated in Table 1. Their total thickness has been estimated by Professor van Ingen at about 10,000 feet in the Conception Bay region. As far as we can judge, with our present knowledge, they appear to be naturally separable on lithological and palaeontological characters into five main divisions—the red and green shales and limestones with the *Callavia, Protolenus* and *Catadoxides* faunas, at the bottom of the column; the gray and black shales and thin gray limestones holding the *Paradoxides* faunas (the lower beds of this division are some-

times red); the gray and black shales and gray sandstones of the Upper Cambrian, containing the *Olenus* fauna; the gray and brown shales and single sandy limestone of the Tremadocian, with *Bryograptus*, *Shumardia*, *Parabolina*, *Princetonia*, and *Niobe;* and the sandstones, shales, and hematite beds of the Arenigian (and possibly Llandeilan) containing *Sphaerobolus*, *Didymograptus*, *Synhomalonotus*, *Schizocrania* and *Westonia*.

These beds occur as widely separated erosion remnants of what was probably, during and following the time of deposition of the later beds at least, a more or less continuous sheet of sediments. Because they have been longest subjected to erosion, the more recent of these beds have been more nearly completely removed, while the most ancient ones have been more extensively preserved.

The Lower Cambrian beds are known to outcrop at Topsail, Manuels, Long Pond Brook, Duff's, and intermediate points on the southeastern side of Conception Bay; at Chapel's Cove, Bacon Cove, Collier's Bay, and Brigus Bay on the western side of Conception Bay; on the western and northern shores of Random Island, and for a considerable distance on the northern shore of Smith Sound, Trinity Bay; and near Little Danzic Cove, which lies southwest of Fortune, on the southern shore of Fortune Bay.

The shales and thin limestones of the Newfoundland series, the Paradoxides Beds, have their best exposure in the gorge of Manuel's Brook, on the southeastern side of Conception Bay, some fifteen miles west of St. John's. This is a locality famous in the annals of North American stratigraphy, and of Cambrian geology in general, as the place where Dr. Walcott, in 1888, found *Paradoxides* beds and *"Olenellus"* beds in the same section—the first time that they had been recognized in America in a single section, and the first time that they had been found anywhere in the world so well developed and richly fossiliferous, and with their stratigraphic positions so clearly shown that their relative ages could be determined beyond question—and was able to demonstrate to everyone's satisfaction that the *Paradoxides* faunas were *younger* than the *Olenellus* faunas, and not *older*, as had been commonly believed up to that time. The Newfoundland beds are also well exposed at Topsail, Chamberlin's Brook, Long Pond, and Kelligrew Brook on the southeastern side of Conception Bay; at Chapel's Cove and on the south side of Brigus Head on the west side of Conception Bay; at Chapple Arm and Island Cove, near the head of Trinity Bay; on the west and north shores of Random Island and the north shore of Smith Sound, Trinity Bay (where the lower beds of the series are red shales and limestones); at Branch, St. Mary's Bay; near Fortune on the south side of Fortune Bay, near Boxey Point on the western shore of the same bay; and on Little Miquelon Island, which is not a part of Newfoundland, but which belongs geologically with that island, as it lies near it geographically.

The Upper Cambrian, "Olenian", Elliott Cove series, forms the part of Random Island which lies southeast of the island's northwestern corner. It is supposed to underlie the mainland on the other side of Smith Sound, to the northeast, though the island along that shore of the Sound is covered with glacial deposits for a considerable distance, and the beds are not known to be well exposed there. The series is also present on the southeastern side of Conception Bay, where it is well exposed in the gorge of Manuels Brook, and on the shore of the bay at Topsail Head. It will probably be found to outcrop also in the valleys of Kelligrew Brook and Seal Cove Brook, southwest of Manuels.

The beds of the Clarenville series, which are of Tremadocian age and older, although they presumably underlie the southeastern part of Conception Bay, are not known to outcrop as a whole above sea-level there, and have been found exposed only about Trinity Bay, where they form the northwestern part of Random Island and a part of the mainland at the western end of Smith Sound, the highest bed of the series, the Riders Brook limestone, occurring only in the latter locality.

The shales and sandstones of the upper division —the Bell Island and Wabana beds, of Arenigian, Lower Ordovician (and perhaps Llandeilan) age— are known only in the Conception Bay basin, and are exposed above sea level only on the three islands, Kelly, Little Bell, and Big Bell Islands, which lie out in that bay, though they must underlie much of the bay, the hematite beds of the Wabana series having been mined for several miles out beneath the sea-bottom northwest of Great Bell Island. The beds which are considered to be possibly of Llandeilan age are exposed on the northwestern side of that island.

In all this great stratigraphic section, from the base of the Cambrian to the uppermost Ordovician beds found, there is no known angular unconformity. Indications that deposition or upward movements of the sea-bottom brought the bottom almost or quite to sea-level have been found at one or more horizons in each of the five stratigraphic divisions described above; but in no case has there been noticed clear evidence of any considerable deformation or subaerial erosion of strata indicating an undoubted stratigraphic break of any importance, though periods of almost complete cessation of deposition seem to have occurred a number of times, and may prove on further

examination to have continued, in some instances, for considerable lengths of time. Concealment of some of the later beds beneath the waters of Conception Bay, between the mainland and Kelly, Little Bell, and Great Bell Islands, and folding of others of the upper beds in Random Island, together with our lack of detailed knowledge of many of the sections on the southern coast-line of southeastern Newfoundland, make it impossible for us to speak more definitely at present about the number or importance of the breaks in this stratigraphic column.

Fossils are common, in some beds at least, in each of the five groups of strata described above. They have not been found in the oldest beds of the Lower Cambrian; they occur in the greatest abundance and variety in the Paradoxidian Newfoundland shales and thin limestones; they are very abundant in some beds of the Upper Cambrian, the Tremadocian, and the Arenigian, but appear to be absent from others. They are sufficiently abundant and well enough distributed in all five divisions to enable us to determine the ages not only of the divisions as a whole, but of most, or all, of the principal parts of each division. They are, too, in many cases so similar to forms occurring in New Brunswick and Cape Breton, on the one side, and Great Britain and Scandinavia, on the other, that we can make close correlations of many of the zones with the corresponding horizons in those regions.

CORRELATION

The correlations of the strata of southeastern Newfoundland with those of the Canadian Maritime Provinces and northwestern Europe are shown in Table 2. An examination of this table will reveal the fact that the zones of the Lower and Middle Cambrian series of southeastern Newfoundland can, in most cases, be accurately identified with zones in southeastern Canada and northwestern Europe, but that the later zones of Newfoundland, while comparable in a general way with those of New Brunswick, Cape Breton, Great Britain and Scandinavia, cannot be correlated so closely. The main reason for our inability to make closer comparisons between these later beds is undoubtedly our lack of a more detailed knowledge of the Newfoundland faunas—a handicap which will be largely removed when the study of Professor van Ingen's collections, which are at Princeton, has been completed. Further studies of collections already made will probably disclose the age of the shales lying between the *Paradoxides davidis* beds and the *Agnostus pisiformis* beds in Newfoundland, some of which shales may prove to belong in the *Paradoxides forchhammeri* zone. The exact relations of the *Catadoixdes* Zone to the *Protolenus* Zone in southeastern Newfoundland is also not well understood. The *Catadoxides* Zone contains an undescribed fauna, which may prove similar to the fauna of the beds lying between the known *Protolenus* beds and the lowest known *Paradoxides* beds of Shropshire, England.

As far as they have yet been studied, the Cambrian-Ordovician faunas of southeastern Newfoundland have proved to be most remarkably similar to the faunas found in strata of the same age in Europe. Further study will undoubtedly add much to our knowledge of the Newfoundland faunas, and will probably enable us not only to recognize a larger number of faunal zones and make further detailed correlations with European and continental North American zones, but will surely disclose the presence of many more species, some of which will resemble closely, or be identical with, European forms, while others will be new or will be forms already known in North America. On the whole, there is good reason to believe that an increased knowledge of the Newfoundland fossils will make this interesting correspondence between the ancient life of the two sides of the Atlantic even more striking that it is now known to be.

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TABLE I.

CAMBRIAN-ORDOVICIAN STRATIGRAPHIC COLUMN OF SOUTHEASTERN NEWFOUNDLAND

SYSTEM	SERIES	ZONE	NATURE OF BEDS	CHARACTERISTIC FOSSILS
	Llandeilan?	*Lingula fraseri* Zone	Black shale, sometimes phosphatic.	*Lingula fraseri* *Schizocrania striata*
	Middle and Upper Arenigian, Wabana Series	Beds with *Didymograptus* and *Synhomalonotus*	Black and gray shales, sometimes phosphatic and pyritiferous, gray sandstones, and red oolitic hematite.	*Synhomalonotus chambersi* *Hemigyraspis cantleyi* *Lingula leseuri* *Schizocrania hayesi* *Didymograptus nitidus*
ORDOVICIAN	Lower Arenigian, Bell Island Series	Beds with *Obolus Linguloboluss*, and *Sphaerobolus*.	Brown and gray sandstones and shales, white sandstone, and, at the top, red oolitic hematite.	*Obolus burrowsi* *Sphaerobolus fimbriatus* *Lingulobolus affinis* *Lingula hawkei* *Lingula murrayi* *Lingula howleyi* *Lingulella billingsi* *Lingulella bella*
	Tremadocian and older Clarenville Series	Beds with *Bryograptus*, *Shumardia*, *Parabolina*, *Princetonia*, and *Niobe*.	Gray and brown shales, with a sandy limestone near the top in at least one locality.	*Shumardia* *Princetonia terranovica* *Parabolina harrieta* *Niobe howelli* *Bellerophon randomi* *Bryograptus*
?	?	*Orusia lenticularis* Zone	Black and brown shales, and thin sandstones.	*Orusia lenticularis*
CAMBRIAN	Upper Cambrian Elliott Cove Series	Zone of *Agnostus pisiformis obesus* and *Olenus*.	Black shales and thin gray sandstones.	*Agnostus pisiformis obesus* *Olenus*
		Agnostus pisiformis Zone	Dark shales.	*Agnostus pisiformis*
	?	Age unknown.	Dark sandy shales.	No fossils yet identified.
	Middle Cambrian Newfoundland Series	*Paradoxides davidis* Zone.	Black, brown, and gray shales sometimes with limestone nodules.	*Paradoxides davidis* *Paradoxides rugulosus* *Corynexochus minor* *Agnostus punctuosus* *Agnostus granulatus*
		Paradoxides hicksi Zone	Black, brown, and olive shales.	*Paradoxides hicksi* *Agraulos socialis* *Agnostus fissus* *Agnostus barrandei* *Agnostus rex* *Eodiscus punctatus*
		Paradoxides bennetti Zone	Green, and sometimes red, shales with limestone nodules and thin beds of limestone.	*Paradoxides bennetti* *Paradoxides eteminicus* *Harttella matthewi* *Conocoryphe elegans* *Agnostus* cf. *rex*
	Lower Cambrian	*Catadoxides* Zone.	Green shales, sometimes with manganiferous shale and limestone in upper part.	*Catadoxides magnificus*
		Protolenus Zone.	Green and red shales, with some manganiferous limestones and phosphatic beds.	*Protolenus*
		Callavia Zone, and possibly a pre-*Callavia* Zone.	Red and green shales, sometimes holding nodules of limestones; red limestones.	*Callavia broggeri* *Strenuella strenua* *Solenopleura bombifrons* *Microdiscus bellimarginatus* *Obclella atlantica* *Coleoloides typicalis*

TABLE II.

CORRELATION OF THE CAMBRIAN-ORDOVICIAN SEDIMENTARY ROCKS OF SOUTHEASTERN NEWFOUNDLAND WITH THOSE OF SOUTHEASTERN CANADA AND NORTHWESTERN EUROPE

System	Southeastern Newfoundland		Southeastern Canada (N.B. and Cape Breton)	Northwestern Europe (Gt. Britain & Scandinavia)
	Series	Zone		
Ordovician	Llandeilan?	*Lingula fraseri* Zone	Not known to be present	Llandeilo of Gt. Britain?
	Middle and Upper Arenigian, Wabana Series	Beds with *Didymograptus* and *Synhomalonotus*	Division 3d of Dr. G. F. Matthew's classification—beds with *Didymograptus* and *Tetragraptus*	Middle and Upper Arenig of Great Britain
	Lower Arenigian, Bell Island Series	Beds with *Obolus*, *Lingulobolus* and *Sphaerobolus*		Lower Arenig of Great Britain
	Tremadocian and older, Clarenville Series	Beds with *Bryograptus*, *Shumardia*, *Parabolina*, *Princetonia* and *Niobe*	Divisions 3a-c of Dr. G. F. Matthew's classification—beds with *Ctenopyge*, *Sphaerophthalmus*, *Peltura*, and *Bryograptus*	Beds with *Shumardia*, *Parabolina*, *Peltura*, *Niobe*, and *Orusia lenticularis*
?	?	*Orusia lenticularis* Zone	?	
Cambrian	Upper Cambrian, Elliott Cove Series	Zone of *Agnostus pisiformis obesus*, and *Olenus*. *Agnostus pisiformis* Zone	Division 2 of Dr. G. F. Matthew's classification—beds with varieties of *Agnostus pisiformis*	Zone of *Agnostus pisiformis obesus* and *Olenus*. *Agnostus pisiformis* Zone (Scandinavia only?)
	?	Unidenitfied Zone	*Paradoxides forchhammeri* Zone?	*Paradoxides forchhammeri* Zone (Scandinavia only?)
	Middle Cambrian, Newfoundland Series	*Paradoxides davidis* Zone	?	*Paradoxides davidis* Zone
		Paradoxides hicksi Zone	*Paradoxides abenacus* Zone	*Paradoxides hicksi* Zone
		Paradoxides bennetti Zone	*Paradoxides lamellatus* and *Paradoxides eteminicus* Zones	*Paradoxides groomi* Zone
	Lower Cambrian	*Catalloxides* Zone	?	?
		Protolenus Zone	*Protolenus* Zone	*Protolenus* Zone
		Callavia Zone, and possibly Pre-Callavia Zone	Etcheminian	*Callavia* and possibly other Pre-Ptotolenus Zones

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